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List of Foreign Pests, Pathogens and Weeds Detected on Introduced Plants

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LIST OF FOREIGN PESTS, PATHOGENS AND WEEDS DETECTED ON INTRODUCED PLANTS[1]

E. E. L e p p i k[2]

Abstract

An average of 2% of introduced seeds, screened at the North Central Regional Plant Introduction Station in Ames, Iowa, was found to be potentially infected by dangerous foreign pathogens new to the United States. Large-seeded legume plants and oil crops contained more; small-seeded grasses and forage crops fewer foreign pathogens. All detected pathogens and weeds were eradicated, and steps taken to avert their spread. From contaminated foreign material disease-free seed was produced in isolated greenhouses for distribution. As a result of this work, the New Crops Research Branch can now offer certified seed free of foreign pests, pathogens, and weeds.

INTRODUCTION

Since seed-borne and systemic pathogens are normally symptomless on dormant seeds, they are difficult to detect and intercept during ordinary quarantine inspection at the port-of-entry stations. Erection of specifically equipped post-entry quarantine stations or central seed-testing laboratories are, therefore, recommended for the inspection of foreign seed shipments (22,23).

In the United States, however, both the detection and eradication of foreign seed-borne pathogens are successfully accomplished in existing regional plant introduction stations. In these stations, introduced seeds are germinated and tested, and plants are grown in greenhouses or in fields for proper evaluation and seed increase. During this procedure, symptoms of seed-borne diseases appear plainly in the maturing plants, and their causative pathogens can be easily detected. In addition, pathogen free seed can be produced in these stations from

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contaminated foreign materials for distribution. Thus, valuable germ plasm of introducted plants can be saved for breeding and crop improvement (9, 13, 18). Since this type of plant propagation requires facilities that are not available at plant quarantine stations, it must be necessarily accomplished at regional plant introduction stations.

HISTORICAL REVIEW

Until 1957 there were no professional plant pathologists employed in the New Crops Research Branch. Some disease evaluation data were assembled by technical personnel during seed increase of introduced plants at the Regional Plant Introduction Stations. Beyond this routine work neither pathological screening nor post-entry surveillance on foreign pathogens were performed at these stations.

These circumstances permitted the entrance and preservation of foreign seed-borne pathogens in cold storages of Plant Introduction Stations. Conventional seed increase procedures in fields or in greenhouses helped these pathogens to reproduce in number and to rejuvenate their vitality. Systematic screening later on brought about the detection and interception of a large amount of foreign pathogens, genetic maladies, some nematodes, and weeds. These are reported in several earlier publications (5-19) and listed at the end of this paper.

The N.-Central Regional Plant Pathologist, first to fill the newly opened position, reported for duty at the Regional Plant Introduction Station, Ames, Iowa, on March 8, 1957. In the beginning, field observations were performed, gathering information about the disease reaction and degree of resistance of introduced plants to our common diseases. In addition, a general list of plant pathogens observed on introduced plants, and a fungus herbarium was made (9).

Actual laboratory work began after detection of several dangerous pathogens on introduced plants that were new for the United States that were evidently imported by seed on introduced material from foreign countries. These pathogens were:

1) a new geographic race of *Ascochyta pisi* Lib. on *Lathyrus*, introduced from Ethiopia,
2) *Cercospora traversiana* Sacc. on *Trigonella foenum-graecum* L., from Ethiopia, and
3) *Alternaria sesami* (Kaw.) Moh. and Behera on *Sesamum indicum* L. from India.

The detection of the above mentioned pathogens was reported to the Plant Quarantine Division in Washington, D. C. and all necessary precautions were applied to prevent the infestation

of local plants with new pathogens. Further tests showed that many more seed samples stored at the Ames Station were infected by foreign pathogens, necessitating the withdrawal of this material from the list of seed offered for distribution by this station.

Professor W. H. BRAGONIER of Iowa State University was one of the first to warn against the danger of foreign seed-borne diseases that might be imported by the vast amount of seed materials introduced by the New Crops Research Branch. W. H. WHEELER, Assistant Director of the Plant Quarantine Division, recognized the danger of the above mentioned foreign pathogens detected at Ames.

Sequestration of large amounts of material that were found infected with foreign pathogens created a new problem for the Regional Stations. Destroying all this material, as enforced by conventional quarantine regulations would mean a serious loss of promising new crops. It was necessary, therefore, to develop new methods to clean the introduced seed from foreign pathogens without reducing the vitality of germ plasm of plants involved.

Since the existing greenhouses were not adequate for such precise pathological work, building of an additional greenhouse was proposed. The new greenhouse, which was completed in 1963, contains small chambers that can be isolated from one another and from outside environment. All compartments can be isolated so that the diseases carrying insects cannot get in or out while foreign pathogens are studied in these particular apartments. Such a greenhouse will be safe for the screening of foreign pathogens and for production of disease-free seed from infected material. W. H. SKRDLA, Regional Coordinator, deserves credit for organizing the planning and construction of this up-to-date glass house unit.

WORLD DISTRIBUTION AND MOVEMENT OF SEED-BORNE PATHOGENS AND INSECT PESTS

Screening of seed collections of introduced plants can produce valuable information concerning the world distribution and movement of inadequately known seed-borne pathogens (5-14). This information is useful for seed-testing laboratories, for plant exploration and introduction, and for plant quarantine and regulatory work (10, 13, 17, 18). Any foreign pest or pathogen detected after its entry must be placed on the list of new diseases (24) so that it can be eradiated quickly if it reappears. Other aspects of seed-borne and systemic pathogens are discussed by KAHN (1), KULIK (2, 4), NOBLE (20), SHEFFIELD (22, 23), STEVENSON (24), and WILKINS (26).

Foreign seed-borne insects and weeds usually pose no serious problems to plant quarantine. Their detection and interception in imported seed samples usually present no technical difficulty and can be successfully accomplished during the quarantine inspection at port-of-entry stations. However, some nematodes, such as Anguillulina agrostis Gernert and Anguina tritici (Steinbuch) Filip., which encyst in grass seeds, can pass unnoticed quarantine inspection (see No. 35 in enclosed list). Therefore they should be watchched for at post entry or plant introduction stations.

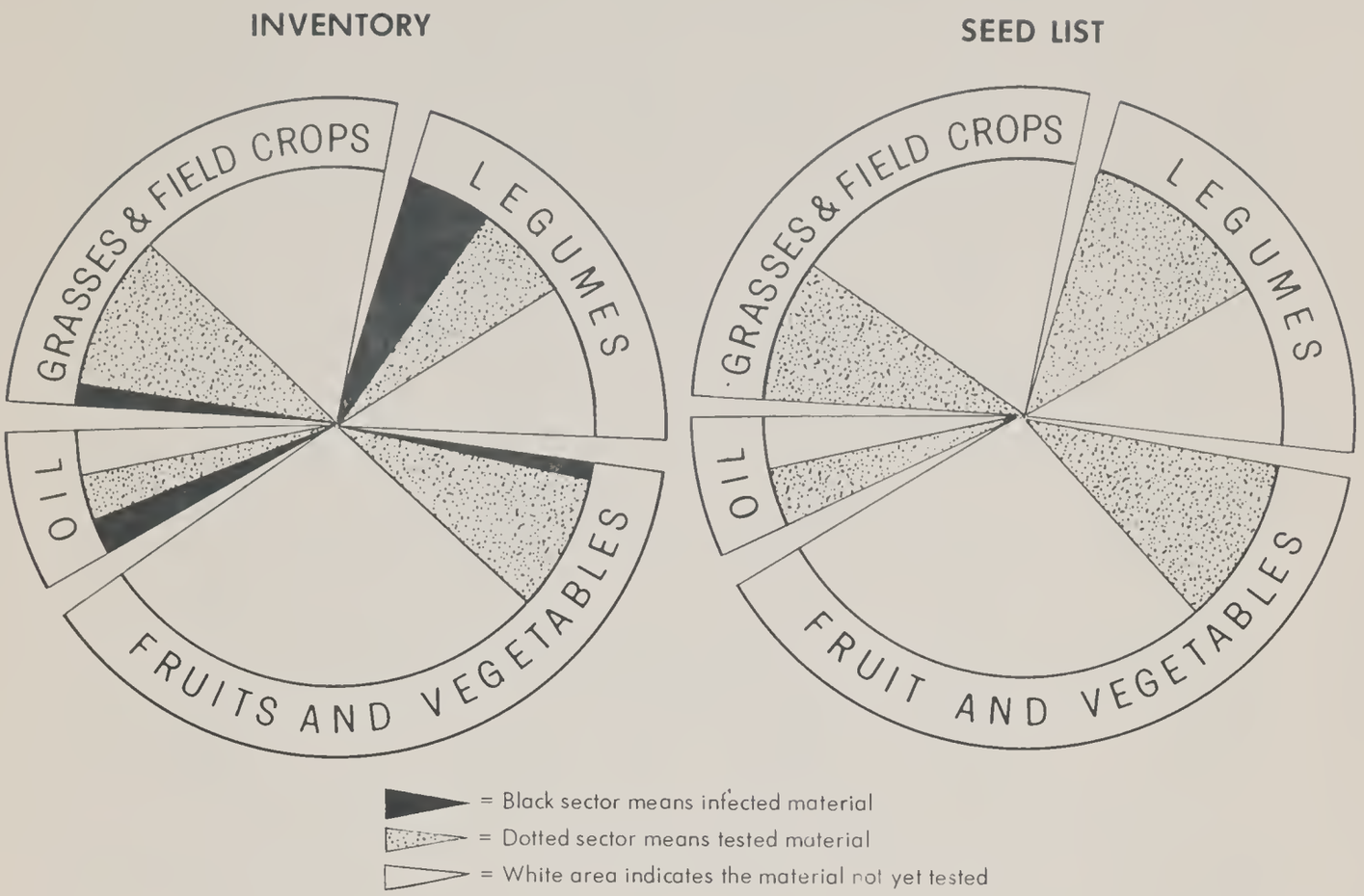
SOME STATISTICS ON FOREIGN SEED-BORNE PATHOGENS

The questions of primary importance are what pathogens and weeds are imported with foreign seeds, where they come from, and how they can be eradicated before they can take hold in our country. The answers were sought during a systematic pathological screening of foreign seed collections stored at the North Central Regional Plant Introduction Station at Ames, Iowa from 1957 to 1965. Several new screening methods were developed for this purpose, and new techniques were evolved to produce disease-free seed from contaminated foreign material (9, 10, 15, 18). At this station 4,489 Plant Introductions of the 13,277 stored accessions were screened, and 269, an average of 2% were found infected with some dangerous foreign pathogens. Also, new data were gathered about the world distribution of seed-borne pathogens and genetic maladies. Thus, reliable information is now available concerning the origin of some of the foreign seed-borne pathogens that threaten our crops. Results of this screening are presented in Table 1 and illustrated in Sketch 1. Several published reports of the study are cited at the end of this paper (5-19).

The highest percentage was detected in large-seeded legumes that are frequent carriers of viruses, bacteria, and systemic fungi. For example, some introduced peas produced plants 17% infected, and some Lathyrus infected up to 21%. Indeed, one collection of Lathyrus introduced from Ethiopia contained a record number of contaminated seeds; 80 percent were infected with a new and dangerous pathogenic race of Ascochyta pisi Lib. (8).

Next in abundance of infection were samples of sunflower and sesame seeds, 10% infected. Vegetables contained an average of 1.6% infected seeds.

Grass and field crop seeds were the least infected (an average of o.75%), but this average does not include corn seed which was almost 100% infected by Fusarium (15).



Sketch 1. Results of the Pathological Screening of introduced plants. Black sectors in left figure indicate the percentage of introductions infected with foreign pathogens. Gray (dotted) sectors represent accessions found free of foreign pathogens. White areas indicate the material not yet tested. Note the relative high percentage of foreign pathogens detected on legume plants and oil crops.

Right figure represent the same introductions after infected plants were eliminated and disease-free seed was produced from infected foreign material, as offered in present seed list of North-Central Plant Introduction Station, Ames, Iowa.

Table 1. Results of the Pathological Screening of introduced plants in Ames, Iowa from 1957 to 1965.

Crops, Groups and genera	1 Inventory	2 Screened	3 Infected	4 %	5 Cleaned	Seed list,[6] disease-free
GRASSES AND FIELD CROPS						
Bromus	392	5	5	1.26	2	359
Panicum	166	1	1	0.60	-	149
Setaria	97	1	1	1.03	-	91
Zea	1913	1580	5	0.26	-	1831
Others	1371	-	-	-	-	1237
Totals	3939	1587	12	0.75	2	3667
LEGUMES						
Astragalus	36	36	3	8.33	-	22
Lathyrus	127	112	34	26.70	80	64
Lotus	614	154	1	0.16	-	574
Melilotus	178	110	1	0.56	1	162
Onobrychis	47	40	5	10.64	-	46
Trigonella	134	64	34	25.36	64	127
Pisum[7]	1269	504	91	7.17	--	1145
Others	648	-	-	-	-	785
Totals	3053	1020	167	16.37	145	2945
FRUITS AND VEGETABLES						
Allium	349	1	1	0.30	-	172
Cucurbita	406	250	8	2.00	-	390
Luffa	3	3	3	-	-	0
Lycopersicon	2650	870	3	0.34	3	1916
Others	1746	-	-	-	-	1475
Totals	5154	1124	15	1.33	3	3953
OIL CROPS						
Helianthus	255	380	35	9.42	176	226
Sesamum[8]	373	378	40	10.60	-	-
Others	503	-	0	-	-	415
Totals	1131	758	75	10.00	176	641

[1]Number of accessions in inventory according to Annual Report for 1963.
[2]Number of accessions screened until 1964.
[3]Number of accessions found infected with foreign pathogens.
[4]Percentage of infected accessions.
[5]Number of accessions cleaned from foreign pathogens.
[6]Number of accessions in 1963 seed list.
[7]Pisum is ~~pathologically~~ a legume plant, although frequently joined with vegetables.
[8]Sesamum is stored in southern Regional Plant Introduction Station, Experiment, Georgia.

LIST OF FOREIGN PATHOGENS, INSECTS AND WEEDS DETECTED AT AMES STATION ON INTRODUCED PLANTS DURING 1958-1964.

A. Fungi and Bacteria (Plates I, II)

1. Alternaria sesami (Kawamura) Mohanty & Behera. Fig. 1. Leaf spot and seed blight of sesame, Sesamum indicum L. Seed introduced from India. Several accessions were infected (19). This fungus now widely distributed in the Southern United States, is a hazard to commercial production of sesame.

2. Ascochyta pisi Lib., on Lathyrus spp. Fig. 2. A new geographic race, detected at the Ames Station on Lathyrus sativus L., and L. cicera L.; seed was introduced from Ethiopia. Several accessions were infected. Disease-free seed was produced from 110 accessions (8).

3. Cercospora sesami Zimm. Leaf spot, detected first on seed and later on leaves on Sesamum indicum L. P.I. 158936 introduced from China (8).

4. Cercospora traversiana Sacc. Fig. 3. Leaf spot on fenugreek, Trigonella foenum-graecum L. Numerous accessions introduced from India and the Near East were infected (5, 6). Disease-free seed was produced from 128 accessions and is available for distribution.

5. Cercospora sp. Fig. 4. Leaf spot on Onobrychis viciifolia Scop.; seed introduced from Turkey on several accessions (8).

6. Macrophomina phaseoli (Maubl.) Ashby on Sesamum indicum L. Fig. 5. P.I. 158040, 220684, introducted from China.

7. Phoma Loticola Diedicke, on Lotus australis Andrews on P.I. 269730, introduced from New Caledonia. This plant has beautiful pink flowers and is native to Australia and New Caledonia, where it is growing on sandy coral beaches. In Ames, the plants were grown from introduced seed in an isolated greenhouse excluding the possibility of local infections.

8. Plasmopara helianthi Novot. var. helianthi Novot. (7), on sunflower, Helianthus annuus L. Fig. 9. Found on seed from Turkey, Pakistan, Russia, and Romania. It is evidently a new geographic race, reported first from Russia (7), then from Yugoslavia, Hungary, and other counties of the Near East. Disease-free seed was produced from 182 accessions (7, 9).

9. Puccinia graminis Pers. on glumes and rachis of Agropyron semicostatum (Steud.) Nees ex Boiss. Fig. 7. P.I. 271522, introduced from India (detected by S. M. DIETZ, Regional Plant Introduction Station, Pullman, Washington,(8).

10. Puccinia recondita Rob. ex Desm. (P. rubigo-vera (DC.) Wint.) on glumes of Bromus lanceolatus Roth, detected

by J. E. MABRY, Jr. Fig. 8. P.I. 255820, seed imported from Afghanistan.

11. Pseudomonas pisi Sackett, bacterial blight of peas, on Pisum sativum L. (fig. 6. This pathogen was first (1915) discovered in Colorado and other Western States, where it caused much damage to garden and field peas. Several foreign counties therefore prohibited importation of peas from America. Latest introductions of peas, however, show that this pathogen is now widely distributed not only in America but also in many foreign counties.

From all infected accessions pathogen-free seed was produced, except the heavily infected P.I. 274308, which was destroyed.

12. Sphacelotheca destruens (Schlecht.) Stevenson & A.G. Johnson on Panicum miliaceum L. P.I. 268411, introduced from Afghanistan.

13. Ustilago bullata Berk. on a seed sample of Bromus danthoniae (Desf.) Trin. P.I. 245732, introduced from Turkey (8).

G. W. FISCHER and C. G. SHAW of Washington State University, Pullman, Washington, confirmed the identification. Although this pathogen is not new for the United States, there is the possibility of introducing a new geographic or pathogenic race which might become epiphytotic in a different environment. Disease-free seed has been produced from this accession, and the original infected seed has been destroyed. Bromus danthoniae is a new host for this smut in the United States.

14. Ustilago crameri Koern, on Setaria Italica (L.) Beauv., P.I. 271609. Seed was collected by J. R. HARLAN from India, No. 1210, 5 km. below Mandi, elevation 1800 meters. Original seed was heavily infected with smut. Therefore, it was destroyed, and no effort was made to reproduce seed free of smut (8).

U. crameri is occasionally found in the United States and Canada, evidently introduced with seed, but its distribution is not yet common in North America.

B. Viruses, Virus-like and Genetic Maladies (Plate I)

15. Chlorotic spots on Astragalus cicer L., Fig. 11. P.I. 246727, A. stella Gouan, P.I. 244309, 244310 A. scorpioides Pourr., P.I. 244277. Seed imported from Spain (8).

16. Chlorotic spots on leaves of Solanum pennellii Correll, P.O. 246502. Seed collected from Chola and Atico. Peru. Fig. 12 (8).

17. Fasciation and witches-broom on Pisum sativum L. Fig. 10. P.I. 269825, 269826. Seed introduced from England (8).

18. Witches-broom on Lathyrus sativus L. On several accessions introduced from India, (P.I. 163293, 183498, 179939); Turkey (P.I. 170470, 170477), and Yugoslavia (P.I. 255368).

19. A mosaic on Melilotus suaveolens Ledeb. Fig. 14. P.I. 251634. Seed imported from Ethiopia. Disease-free seed has been produced in the greenhouse (8).

20. A mosaic on Lycopersicon esculentum Mill. Fig. 18. Seed collected from El Salvador, P.I. 272833 (8).

21. Muskmelon mosaic (obviously Marmor melonis Rader) on Cucurbita pepo L., P.I. 176551, introduced from Turkey; P.I. 285611, introduced from Poland. In both cases only a few plants were infected (early after germination). Infected plants were eradicated before the pathogen could spread in the field. No other plants were found infected in the later stages of development. Pathogen-free seed is available.

22. Tomato mosaic virus (obviously Marmor tabaci strain vulgare Holmes) on Lycopersicon esculentum Mill. P.I. 272629 and 272996, introduced from Cojutepeque, El Salvador, Central America. This pathogen was imported for the second time from the same place (Cojutepeque) on tomato seed. First detection was made in June 4, 1962 on P.I. 272833. All infected plants were eradicated and disease free seed was produced from this accession for distribution.

23. Necrotic spot on corn, Zea Mays L., introduced from Argentina P.I. 198905, 213763. Fig. 15 (8).

24. Pea stunt virus (obviously Marmor trifolii Holmes), Fig. 13. Originally named by D. J. HAGEDORN Wisconsin, as Pea Stunt. This is admittedly an American disease which has been distributed in many European countries. Seed samples from England, Germany and Poland were heavily infected. Collections from the Near and Far East have not shown this disease.

25. Ringspot virus on Koehleria amabilis Fritsch. Fig. 16. Plant introduced from Portugal. P.I. 238875.

26. A squash mosaic (obviously Marmor melonis Rader var. obscurum C. W. Anderson) on Cucurbita maxima Duchesne. Fig. 17. P.I. 137896, 141660, 143306 introduced by seed from Iran and distributed in Ames by cucumber beetles. After several years of intensive work it was finally eradicated and disease-free seed was produced (11).

27. Striped leaves of Melilotus alba Desr. P.I. 253454 from Ygoslavia (8).

28. Yellow-dwarf (obviously Marmor cepae Holmes) on bulbs of Allium sp. P.I. 252051 from Iran. Repeated attempts to grow these plants in the greenhouse and to produce disease-free plants out of infected bulbs failed. This P.I. was destroyed.

29. Yellow spots on Cucurbita pepo L. from India, P. I. 165558 (8).

30. Yellow spots on luffa, Luffa cylindrica (L.) Roem. P.I. 223785 and L. acutangula (L.) Roxb. P.I. 179695, 254555. Seed introduced from Afghanistan (8).

31. Yellow streaks on Cucurbita pepo L. Fig. 19. Introduced from India P.I. 285611.

C. Parasitic Plants

32. Cuscuta pentagona Engelm. Imported with Lactuca seed from Iran, P.I. 229699. Dodder-free seed was produced from this accession (8).

33. Cuscuta sp. on Robinia pseudo-acacia L. P.I. 257022; seed introduced from Afghanistan. Dodder-free plants were produced in greenhouse (8).

D. Insects and Nematodes

34. Dinoderis minutus Fab., bamboo powder-post beetle was imported with bamboo stakes from Japan and spread in Ames rapidly in greenhouses. Disinfection in autoclave was effective.

35. Anguillulina agrostidis Gernert on seed of Festuca rubra L. introduced from Yugoslavia. All seed was heavily infected and had to be burned.

E. Weeds

36. Carthamus tinctorius L. Safflower, as weed among sunflower seed, introduced from Egypt, P.I. 250085.

37. Lepidium sativum L., family Cruciferae. Introduced within Brassica sp. seed from West Pakistan, P.I. 179846, 219576, 269448 (det. R. C. ROLLINS Harvard University).

Accessions P.I. 219576 and 269448 were also grown at the Agronomy Farm of the University of Indiana, and both contained this weed observed by ALBERT DODGE, June 20, 1961.

38. Metaplexis japonica (Thunb.) Makino. This oriental milkweed (family: Asclepiadaceae) was first collected by WELSH and ANDERSON (25) from a corn field bordering the Plant Introduction Station at the Agronomy Farm of the Iowa State University in June 1958. Further observations showed that the plant

was spreading through the field mainly by rootstocks which break by cultivation. The stems twine in bindweed fashion on corn plants. Blooming period was from mid-June to September with a considerable amount of seed being produced. In spite of control measures, living plants were found until 1963. After this time, it was no longer observed.

So far, this is the first report of M. japonica being found in North America. WELSH and ANDERSON (25) suppose that the plant was introduced during World War II when milkweeds were being investigated as a source of fiber.

39. Vaccaria pyramidata Medik. (V. vulgaris Hort.) was included in seed of Brassica campestris L. introduced from India, P.I. 180264.

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Figs. 1-19. 1. Alternaria sesami on Sesamum indicum.- 2. Ascochyta on Lathyrus sativus. - 3. Cercospora traversiana on leaf of Trigonella foenum-graecum.- 4. Cercospora sp. on Onobrychis viciaefolia. - 5. Macrophomina phaseoli on seeds of Sesamum indicum. - 6. Pseudomonas pisi on Pisum sativum. - 7. Puccinia graminis on glumes and rachis of Agropyron semicostatum. 8. Puccinia recondita on glumes of Bromus lanceolatus. - 9. Plasmopara halstedii on Helianthus annuus. - 10. Fasciation and witches-broom on Pisum sativum. - 11. Chlorotic spots on Astragalus cicer. - 12. Chlorotic leaf of Solanum pennellii. - 13. Symptoms of pea stunt virus. - 14. Mosaic on Melilotus suaveolens. - 15. Necrotic spots on corn leaf. - 16. A ringspot virus on Koehleria. - 17. Symptoms of squash mosaic on Cucurbita. - 18. Mosaic on leaf of Lycopersicon esculentum. - 19. Yellow streaks on Cucurbita.